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(71) Applicant (*for all designated States except US*): TELEFONAKTIEBOLAGET LM ERICSSON (PUBL) [SE/SE]; S-126 26 Stockholm (SE).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): LUNDBÄCK, Robert [SE/SE]; Svärdliljevägen 146, S-165 77 Hässelby (SE). MARKSTRÖM, Kjell [SE/SE]; Jungfruvägen 20, S-906 37 Umea (SE). SÖDERLUND, Ola [SE/SE]; Envägen 31, S-911 30 Vännäs (SE). TORNEUS, Anders [SE/SE]; Lagmansgatan 60 D, S-903 60 Umea (SE). MANSSON, Lars [SE/SE]; Björnbärsvägen 105, S-904 35 Umea (SE). CIGEHN, Peter [SE/SE]; Björnvägen 458 B, S-906 43 Umea (SE).

(74) Agent: O'CONNELL, David, Christopher; Haseltine Lake & Co., Imperial House, 15-19 Kingsway, London WC2B 6UD (GB).

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(54) Title: TELECOMMUNICATIONS SYSTEM

(57) Abstract: A base station (1) has a processor (3) for controlling the operation of the base station. The processor (3) receives measurement reports (7) form a plurality of channel devices 5_1 5_n, each channel device (5) performing measurements on its respective channel. The processor (3) sends external measurement reports (9) to an external system (11), for example a radio network controller (RNC). Overload of the processor (3) is avoided by reducing the rate at which measurement reports (7) are sent to the processor (3) when the load of processor (3) is determined as exceeding a given threshold. The channel devices (5) are allowed to increase their reporting rates after the load of the processor falls again to an acceptable level. In addition to avoiding overload conditions, the system enables a given processor to handle an increased number of channel devices (5). The system may also be used to avoid overload at an interface. The measurement reports may be reduced in a number of ways, for example only reporting when a new measurement deviates from a previously reported measurement by a predetermined amount.

TELECOMMUNICATIONS SYSTEM

FIELD OF INVENTION

The invention relates to a telecommunications system, and in particular, to avoiding overload in a telecommunications system, for example by reducing the amount of traffic relating to measurement reporting. The invention can be used to avoid processor overload or interface overload.

BACKGROUND OF THE INVENTION

Figure 1 shows an over view of a typical telecommunications system. A radio base station (RBS) 1 comprises a processor 3 for controlling the operation of the base station 1. Among the various tasks performed by the processor 3, one aspect is to manage a number of channel devices $5_1 \ldots 5_n$. Each channel device 5 performs measurements on its respective channel, which are reported by way of measurement reports $7_1 \ldots 7_n$ to the processor 3. Typically, the measurements relate to the channel quality, for example, signal to noise ratio, or downlink transmitted code power.

Each of the plurality of channel devices 5 will therefore send measurement reports 7 to the processor 3 at a particular rate. Different channel devices 5 may send measurement reports 7 at different rates depending, for example, on what is being reported by the particular channel device 5. Based on the information contained in the measurement reports 7, the processor 3 sends external measurement reports 9 to an external system 11, for example a radio network controller (RNC).

The transportation of measurement reports 7 to the processor 3, coupled with the sending of external measurement reports 9 from the processor 3 to an external system 11, contribute significantly to the load of the processor 3. The sending of measurement reports 7 also contributes significantly to the processing load of each of the channel devices 5. For example, if several hundred channels are being controlled with each channel having periodic measurements, say once every second, then several hundred measurement reports-will be transported within the processor 3 per second.

There is therefore a risk that, if the processor 3 has to handle a large number of measurement reports 7 and 9, then the processor 3 can enter an overload condition. For real-time systems, fast response times are essential, and loading the processor 3 too high can cause timing problems. For example, the system can become slow with long response times. If the overload condition is prolonged, the system can crash, or cause a re-start of the system.

Therefore, it can be seen that the handling of measurement reports 7 and 9 forms a large part of the processing load of a base station controller.

US 4,974,256 is an example of a telecommunications system having means for preventing the overload of a controlling processor. This patent describes how the occupancy of a processor is measured, and, when its occupancy exceeds a predetermined threshold, the load is shed to other processors. Although this system avoids processor overload, it does so by off-loading tasks to other processors when a CPU overload is

detected. The other processors then process the tasks in parallel with the first processor. Such a system has the disadvantage that it increases the cost of the telecommunications system, and requires complex processing to control the parallel operations performed by the plurality of processors.

In addition to overloading a processor, measurement reports can also cause interface load problems. For example, a situation can arise whereby a large number of measurement reports must-be transmitted over an interface with limited bandwidth.

Figure 2 shows a telecommunication system having several levels of processing, which are interconnected by several interfaces.

A controlling processor 21 can be connected to one or more channel cards 23_1 to 23_m via an interface A. Each channel card 23 may have its own processor, 25_1 to 25_m, respectively. A processor 25 may in turn interface with one or more card sub-processors CSP_1 to CSP_n, shown as items 27, via an interface B.

It can be seen that, if the number of measurement reports exceed the bandwidth of a given interface, A or B, then the telecommunications system can become overloaded.

The aim of the present invention is to provide a method and apparatus which avoid or reduce the likelihood of overload occurring in a processor or interface, by controlling the handling of measurement reports in the telecommunications system.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a method of preventing an overload condition at a node in a telecommunications system, in which the node receives reports from a plurality of reporting devices, the method comprising the steps of: monitoring the load of the node; and controlling the rate at which reports are sent from at least one of the reporting devices to the node in accordance with the monitored load.

According to another aspect of the invention, there is provided a method of reducing the number of measurement reports transmitted in a telecommunications system, the method comprising the steps of: performing a measurement; comparing the measurement with a previously reported measurement; determining whether the difference is greater than a predetermined amount; and, if so, reporting the measurement.

According to another aspect of the invention, there is provided a telecommunications system having a node which receives reports from a plurality of reporting devices, the telecommunications system comprising: means for determining the load at the node; and controlling means for controlling the rate at which reports are sent from at least one reporting device to the node, in accordance with the determined load at the node.

According to another aspect of the invention, there is provided a telecommunications system comprising one or more reporting devices for sending measurement reports to other parts of the telecommunications system, at least one of the reporting devices comprising: means

for performing a measurement; means for comparing the measurement with a previously reported measurement; and means for reporting the measurement only if the deviation from the previously reported measurement is more than a predetermined value.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 shows an overview of a typical telecommunications system;

Figure 2 shows a more detailed view of a telecommunications system;

Figure 3 shows the steps involved in avoiding overload according to one aspect of the present invention;

Figure 4 illustrates how load varies over time in response to the method described in Figure 3;

Figure 5 illustrates how processor load varies over time in response to another aspect of the present invention.

Figure 6 shows how the number of measurement reports may be reduced according to another aspect of the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE PRESENT INVENTION

Referring to Figure 3, the load of a processor, for example the processor 3 shown in Figure 1, is monitored to determine the load at any point in time, step 101. The load of the processor is checked to determine whether it has crossed a first threshold T_1, step 103. If the load is below threshold T_1, no action is taken, and the system continues to monitor the load, while continuing to process measurement reports as normal. However, if the load of the processor is determined as being above threshold T_1, the system will instruct at least one of the channel devices 5 to reduce the rate at which it sends measurement reports 7 to the processor 3, step 105.

It is noted that the tasks of monitoring the load of processor 3 and controlling the channel devices 5 may be performed by processor 3 itself. Alternatively, this task may be performed by some other part of the system.

The reduction in the number of measurement reports 7 may be achieved in a number of ways, as will be discussed in greater detail later in the application.

Over time, the reduction of measurement reports 7 being sent from the channel devices 5 to the processor 3 will result in the load of processor 3 falling.

During this time the load of the processor 3 is monitored, in step 107, and checked in step 109 to determine whether the load has fallen below a second threshold T_2. If the load has not fallen below

threshold T_2, the system will continue to monitor the load, step 107.

When the load falls below threshold T_2, the processor 3 will instruct one or more channel devices 5 to increase the rate at which they send measurement reports 7 to the processor 3, step 111.

Advantageously, the value of the threshold T_1 is set above the value of threshold T_2, thereby providing a hysteresis, which avoids the channel devices having to change rates too often.

It is noted that if the system determines in steps 107 and 109 that the load of the processor 3 is not falling to an acceptable level, or if the load is not falling quickly enough, then the processor 3 may instigate a further reduction in the number of measurement reports 7 being received from the channel devices 5. However, it is noted that further reduction of the reporting rate, would be meaningless if the measurement reporting was not a significant contributor to the processor load. Thus, there is preferably a lower limit to the amount the measurement reports are reduced.

Figure 4 shows the load of processor 3 during a typical operating cycle according to the present invention. As the load of processor 3 increases it crosses threshold T_1. The threshold T_1 may be set to be, say, 90% of the maximum load of the processor. This will cause the processor 3 to instruct one or more of the channel devices 5 to reduce the rate at which it sends measurement reports 7 to the processor 3. This will result in the load of processor 3 falling over time. When the load crosses the second threshold T_2, the

processor 3 will instruct one or more of the channel devices to increase the rate at which they send measurement reports 7 to the processor 3. Ideally, each of the channel devices 5 will send measurement reports 7 at its normal reporting rate.

As can be seen, T_2 is preferably lower than T_1, thereby providing an in-built hysteresis in the system. As mentioned earlier, this avoids the undesirable effect of causing the channel devices 5 to change reporting rates too often.

Preferably, the system has the ability to learn the behaviour of the system, so that it can learn how the load of the processor 3 is affected by the rate at which it receives measurement reports 7 from the channel devices 5. This information can be used to fine tune the performance of the system during use, so that it can accurately predict how many measurement reports must be eliminated in order to reduce the load of the processor 3 to an acceptable level. With such a feature, an additional step may be performed between steps 103 and 105, or 109 and 111, in which historical data is used to determine how the reporting rates are to be reduced.

Fine tuning arrangements can include the use of timers which block the system from returning to normal reporting mode for a predetermined time. Also, the thresholds and time delays can be configurable or adjusted by the learning feature.

Figure 5 shows the load of processor 3 during a typical operating cycle according to another embodiment of the present invention. According to this embodiment, there

are additional threshold levels, resulting in the reporting rates being changed more frequently. As the load of processor 3 increases it crosses threshold T_a. This will cause the processor 3 to instruct one or more of the channel devices 5 to reduce the rate at which it sends measurement reports 7 to the processor 3. This should result in the load of the processor 3 falling. However, if the load of the processor 3 continues to rise beyond a second threshold T_b, the processor 3 will instruct the channel devices 5 to send fewer measurement reports 7. As the load of the processor 3 falls below threshold T_c, the processor 3 will instruct one or more of the channel devices 5 to increase the rate at which measurement reports are sent. As the load continues to fall beyond threshold T_d, the processor 3 will instruct more of the channel devices to increase the rate at which measurement reports are sent. Ideally, at this point, each of the channel devices 5 will be sending measurement reports 7 at its normal reporting rate.

It is noted that the number of thresholds could be increased further. Indeed, it is also possible that the channel devices 5 could be continually controlled in relation to the load of the processor 3.

The method and system for avoiding overload described above have the advantage that a given processor can handle more channel devices, thereby having greater capacity. Alternatively, a system having a given number of channel devices can make use of a slower, and thereby cheaper, processor, thereby reducing the cost of the overall system.

According to another aspect of the invention, the same

inventive concept as described above in relation to avoiding overload in a processor, can also be used to avoid overload in an interface, such as interface A or interface B shown in Figure 2.

As above, referring again to Figure 3, the load of an interface shown in Figure 2 is monitored to determine the load at any point in time, step 101. The load of the interface is checked to determine whether it has crossed a first threshold T_1, step 103. If the load is below threshold T_1, no action is taken, and the system continues to monitor the load, while continuing to send measurement reports as normal. However, if the load of the interface is determined as being above threshold T_1, the system will instruct at least one of the reporting devices, for example a channel card processor 25 or channel card sub-processor 27 to reduce the rate at which measurement reports are sent to the interface A or B respectively, step 105.

Over time, the reduction of measurement reports being sent, for example from a card sub-processor CSP_1 to a card processor 25_1 in Figure 2, will result in the load of interface B falling.

During this time the load of interface B is monitored, in step 107, and checked in step 109 to determine whether the load has fallen below a second threshold T_2. If the load has not fallen below threshold T_2, the system will continue to monitor the load, step 107.

When the load falls below threshold T_2, the card sub-processor CSP_1 may be instructed to increase the rate at which it sends measurement reports to the card processor 25_1, step 111.

Preferably, the value of the threshold T_1 is set above the value of threshold T_2, thereby providing a hysteresis, which avoids the card sub-processors CSP_{1-n} having to change rates too often.

It is noted that if the system determines in steps 107 and 109 that the load of the interface B is not falling to an acceptable level, or if the load is not falling quickly enough, then steps can be taken to instigate a further reduction in the number of measurement reports being received from the card sub-processors CSP_{1-n}.

A more detailed explanation will now be given as to how the number of measurement reports may be reduced.

According to one aspect of the invention, the number of measurement reports may be reduced by instructing a particular channel device, card processor or card sub-processor to send measurement reports on every other cycle.

According to another aspect of the invention, the number of measurement reports could be reduced by prioritizing between different types of measurements, measurements done on different channel types and measurements carried out for different purposes. In the latter case, measurements which are needed to maintain channels that have previously been set up can be given priority over less important measurements, such as performance management measurements. In this situation, performance management measurements would be reported at a reduced rate, before reducing the reporting rate of more important measurements.

According to another aspect of the invention,

measurement reports may be reduced by only reporting a new value when the new value deviates from the previously reported value by more than a predetermined amount, referred to hereinafter as the reporting deviation threshold.

For a given system behaviour, in general terms the smaller the reporting deviation threshold, the larger the number of measurement reports which are sent, and vice versa.

Referring to Figure 6, a new measurement is performed, step 201, and compared with the value of the previously reported measurement, step 203. Next, it is determined whether the value of the new measurement deviates from the value of the previously reported measurement by a predetermined amount, the reporting deviation threshold, as shown in step 205.

If the deviation is less than the threshold, then no report is made and the system returns to carry out the next scheduled measurement. If the deviation is more than the threshold, then the new measurement is reported, step 207.

This procedure continues, with the measurement reported in step 207 becoming the "previously reported measurement" for future comparisons in step 203.

Thus, the actual measurements are carried out at the same frequency as normal, but are only reported if the new measurement deviates from the previously reported measurement by a value which is greater than the reporting deviation threshold.

For example, assume that measurements have integer values, the measurement interval is 10ms, and the reporting deviation threshold is set to 5. If it is then assumed that the following sequence of measured values are made:

4,6,9,11,15,13,17,20,26,22,25,30,28,29,35,33,29,27,23,19,20,16,13,

then the following measurements will be reported:

4(10ms), 9(30ms), 15 (50ms), 20(80ms), 26(90ms), 35(150ms), 29(170ms), 23 (190ms), 16(220ms).

Thus, instead of reporting 23 values, only 9 values are reported.

The reporting deviation threshold may be varied, for example in response to load conditions, so that the deviation threshold is increased when traffic is heavy, and reduced when traffic is light.

Although this form of measurement reduction has been described in relation to reducing overload conditions at a processor or interface, this aspect of the invention may equally be applied to reducing the number of measurement reports in more general terms.

In the various aspects of the invention described above, it has been assumed that fewer measurement reports are reported during the overload condition. However, certain nodes in the telecommunications system may have constraints imposed upon them by external systems. For example, an external system may have a requirement that measurement reports are sent to it at

a set frequency. Thus, if a node sending measurement reports to such an external system is itself receiving measurement reports at a reduced rate, then steps need to be taken to ensure that the node can nevertheless send external measurement reports at the desired frequency.

This may be accomplished, for example, by sending "dummy" measurement reports when there is no valid data available for transmission. For example, if a particular node is only receiving measurement reports in alternate cycles, the node can send dummy measurement reports to an external system during the alternate cycles when it is not receiving reports itself. A dummy report may be a repeat of the previous measurement report, or a value which is extrapolated from previous measurement reports.

In the embodiment of Figure 6, if an external system requires measurement reports to be reported at a particular frequency, then, during the periods when no reports would normally be sent (e.g. at the time slots corresponding to 20ms, 40ms, 60ms, 70ms, 100ms, 110ms, 120ms, 130ms, 140ms, 160ms, 180ms, 200ms, 210ms in the example above), a repeat of the previous report could be resent.

For example, in the example described above, the external interface could report:

4,4,9,9,15,15,15,20,26,26,26,26,26,26,35,35,29,29,23,23,23,16,16.

The deviation from the actual measured values will then be: 0,2,0,2,0,2,2,0,0,4,1,4,2,3,0,2,0,2,0,4,3,0,3.

This equates to an average deviation of 36/23=1.57 from the true measurement value.

The arrangements described above have the advantage that the invention can be adopted in a particular environment without having to modify the interface to an external system, and without any of the external systems having to modify their own processing arrangements.

Furthermore, the invention has the advantage that no modifications are required to any external systems since the invention can continue to send measurement reports to external systems at the same rate.

Alternatively, rather than have the reporting device send the previous measurement value when a constant measurement rate is required, the receiver of the measurement data could remember the last reported value.

The invention also has the effect of increasing system stability since overload is prohibited and response times become faster as CPU load, or interface load is reduced. Timing problems are also avoided, together with possible crash problems, resulting in less disturbance to the telecommunications system.

Although the preferred embodiment is concerned with reducing the effect of measurement reports, it will be appreciated that the invention is equally applicable to other forms of data being received from a plurality of devices at different rates.

CLAIMS.

1. A method of preventing an overload condition at a node in a telecommunications system, in which the node receives reports from a plurality of reporting devices, the method comprising the steps of:

monitoring the load of the node; and

controlling the rate at which reports are sent from at least one of the reporting devices to the node in accordance with the monitored load.

2. A method as claimed in claim 1, further comprising the step of determining whether the load has crossed a first threshold, and, if so, decreasing the rate at which at least one of the reporting devices sends reports to the node.

3. A method as claimed in claim 1 or 2, further comprising the step of determining whether the load has crossed a second threshold, and, if so, increasing the rate at which at least one of the reporting devices sends reports to the node.

4. A method as claimed in any one of the preceding claims, wherein the rate at which reports are sent may be varied in accordance with at least one further threshold being crossed.

5. A method as claimed in claim 2, wherein the step of decreasing the rate at which messages are sent from a reporting device involves instructing the reporting device to omit certain reports which it would normally send to the processor.

6. A method as claimed in claim 5, comprising

instructing the reporting device to omit alternate reports which it would normally send to the processor.

7. A method as claimed in claim 2, wherein the step of decreasing the rate at which reports are sent from a reporting device involves instructing the reporting device to only send reports when a new reporting value deviates from a previously sent reporting value by a predetermined amount.

8. A method as claimed in-claim 7, wherein the predetermined amount may be changed.

9. A method as claimed in claim 3, wherein the first threshold is higher than the second threshold.

10. A method as claimed in any one of the preceding claims, further comprising a self learning function for learning how the load of the node changes in response to the rate at which reports are received, and using this information to control the rate at which reports are sent from reporting devices.

11. A method as claimed in any one of the preceding claims, wherein the reports are measurement reports.

12. A method as claimed in any one of the preceding clams, wherein the node is a processor.

13. A method as claimed in any one of claims 1 to 11, wherein the node is an interface.

14. A method of reducing the number of measurement reports transmitted in a telecommunications system, the method comprising the steps of:

performing a measurement;

comparing the measurement with a previously reported measurement;

determining whether the difference is greater than a predetermined amount; and, if so,

reporting the measurement.

15. A method as claimed in claim 14, wherein the predetermined amount may be changed.

16. A telecommunications system having a node which receives reports from a plurality of reporting devices, the telecommunications system comprising:

means for determining the load at the node; and

controlling means for controlling the rate at which reports are sent from at least one reporting device to the node, in accordance with the determined load at the node.

17. A telecommunications system as claimed in claim 16, wherein the controlling means comprises:

means for determining whether the load has crossed a first threshold; and

means for decreasing the rate at which at least one of the reporting devices sends reports to the node in response to the first threshold being crossed.

18. A telecommunications system as claimed in claim 16 or 17, wherein the controlling means comprises:

means for determining whether the load has crossed a second threshold; and

means for increasing the rate at which at least one of the reporting devices sends reports to the node in response to the second threshold being crossed.

19. A telecommunications system as claimed in claim 17 or 18, wherein the means for increasing and/or decreasing the rate at which at least one of the reporting devices sends reports to the node acts in accordance with at least one further threshold being crossed.

20. A telecommunications system as claimed in claim 17, wherein the means for decreasing the rate at which messages are sent from a reporting device comprises means for instructing the reporting device to omit certain reports which it would normally send to the node.

21. A telecommunications system as claimed in claim 20, comprising means for instructing the reporting device to omit alternate reports which it would normally send to the node.

22. A telecommunications system as claimed in claim 17, wherein the means for decreasing the rate at which reports are sent from a reporting device includes means for instructing the reporting device to only send reports when a new reporting value deviates from a reporting value sent in a previous report by a predetermined amount.

23. A telecommunications system as claimed in claim 22, wherein the predetermined amount may be changed.

24. A telecommunications system as claimed in claim 18, wherein the first threshold is higher than the second threshold.

25. A telecommunications system as claimed in any one

of claims 16 to 24, further comprising self learning means for learning how the load of the node changes in response to the rate at which reports are received, and using this information to control the rate at which reports are sent from reporting devices.

26. A telecommunications system as claimed in any one of claims 16 to 25, wherein the reporting devices are channel devices, channel card processors or channel card sub-processors.

27. A telecommunications system as claimed in any one of claims 16 to 26, wherein the node is a processor.

28. A telecommunications system as claimed in any one of claims 16 to 26, wherein the node is an interface.

29. A telecommunications system comprising one or more reporting devices for sending measurement reports to other parts of the telecommunications system, at least one of the reporting devices comprising:

means for performing a measurement;

means for comparing the measurement with a previously reported measurement; and

means for reporting the measurement only if the deviation from the previously reported measurement is more than a predetermined value.

30. A telecommunications system as claimed in claim 29, wherein the predetermined value may be changed.

31. A method of preventing overload in a telecommunications system, the method being substantially as hereinbefore described, with reference to, and as shown in Figures 3 to 6 of the accompanying

drawings.

32. A telecommunications system substantially as hereinbefore described, with reference to, and as shown in Figures 3 to 6 of the accompanying drawings.

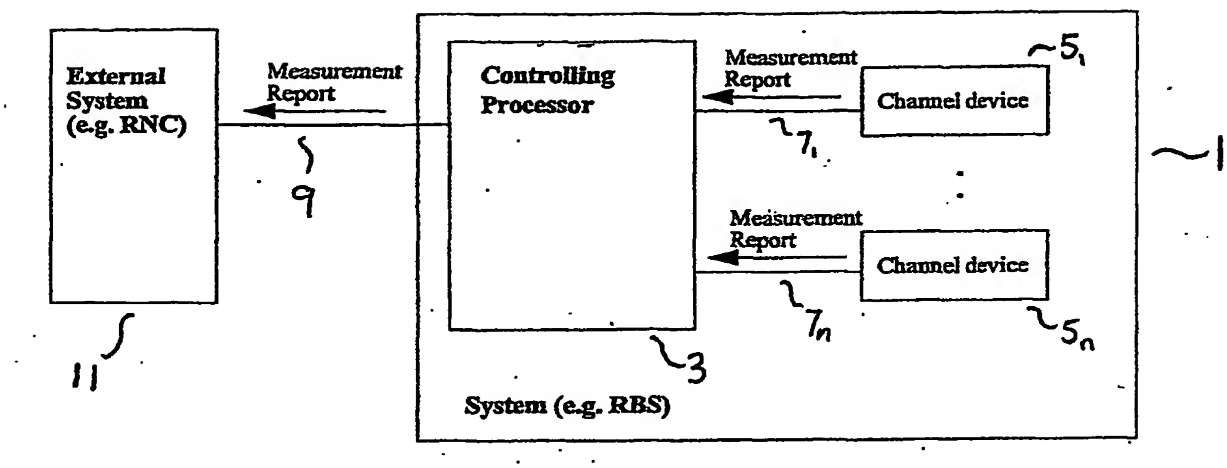
External System (e.g. RNC)
Measurement Report
9
11
Controlling Processor
3
Measurement Report
Channel device
5₁
7₁
Measurement Report
Channel device
7n
5n
1
System (e.g. RBS)

FIG 1.

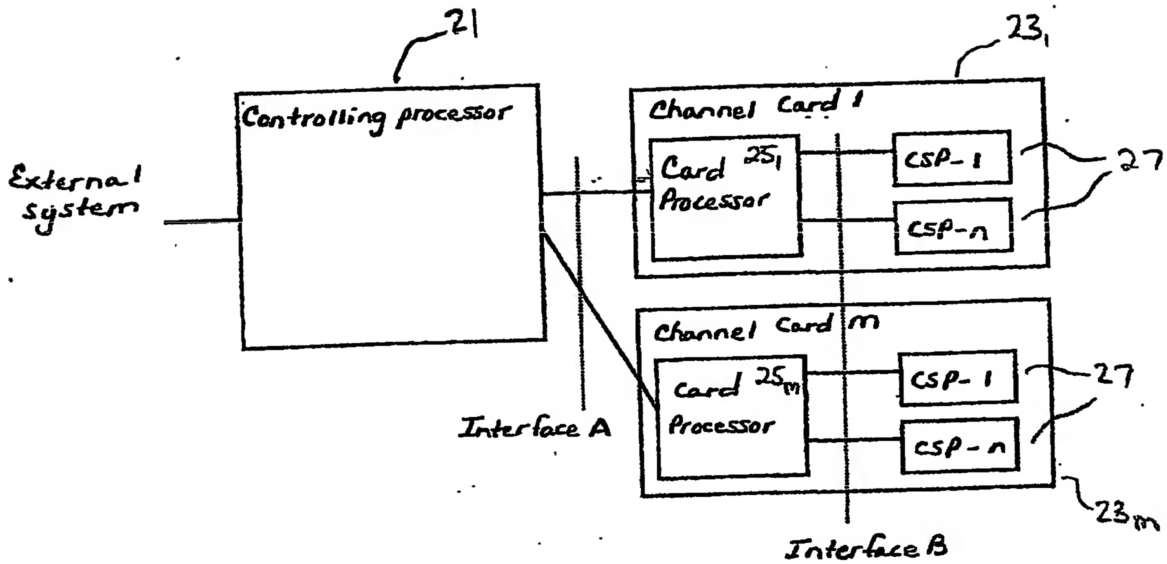
21
Controlling processor
External system
23₁
Channel Card 1
Card Processor
25₁
CSP-1
CSP-n
27
Channel Card m
Card Processor
25m
CSP-1
CSP-n
27
Interface A
Interface B
23m

FIG 2.

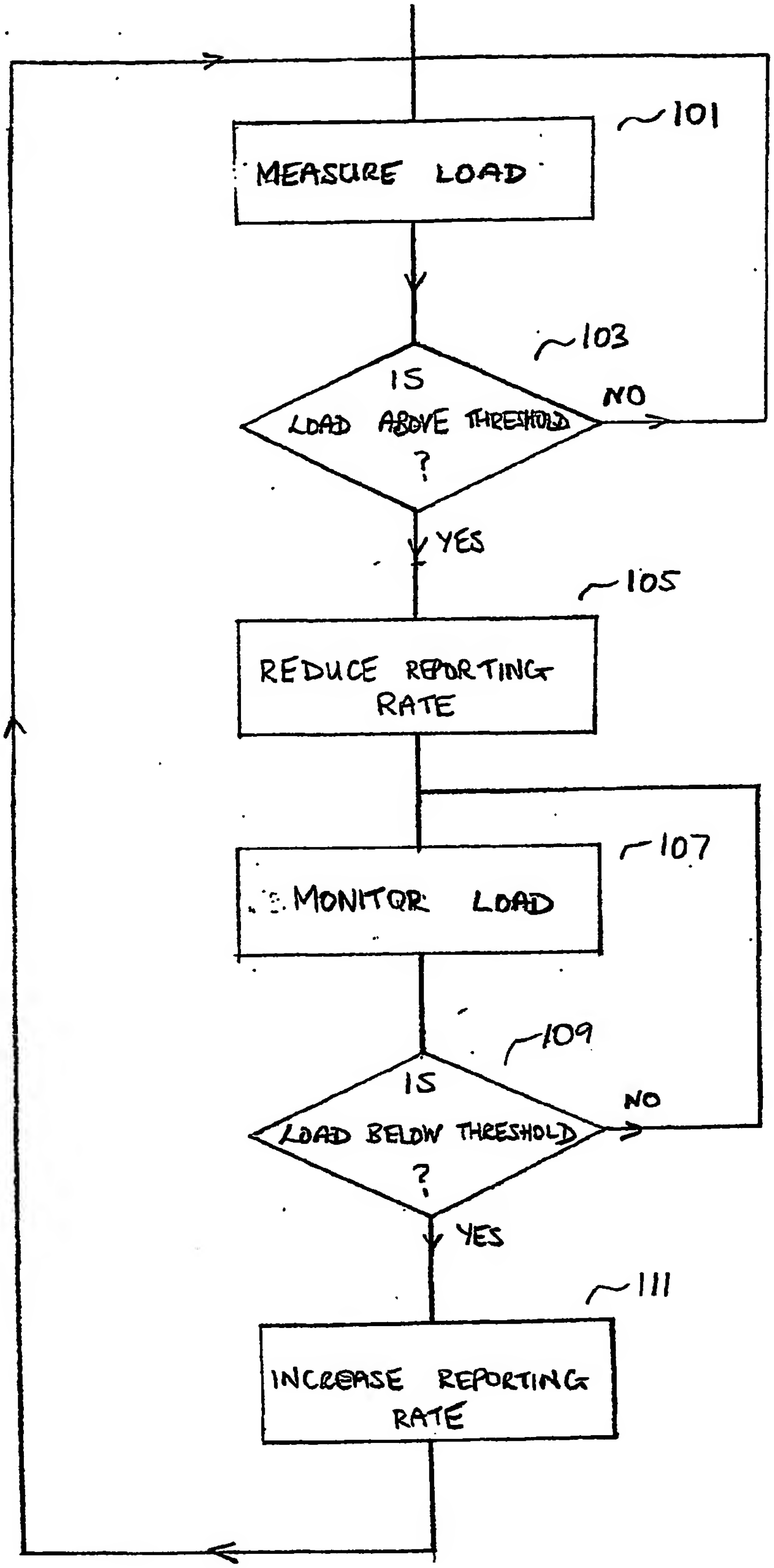
MEASURE LOAD
101
IS LOAD ABOVE THRESHOLD ?
103
NO
YES
REDUCE REPORTING RATE
105
MONITOR LOAD
107
IS LOAD BELOW THRESHOLD ?
109
NO
YES
INCREASE REPORTING RATE
111

FIG. 3

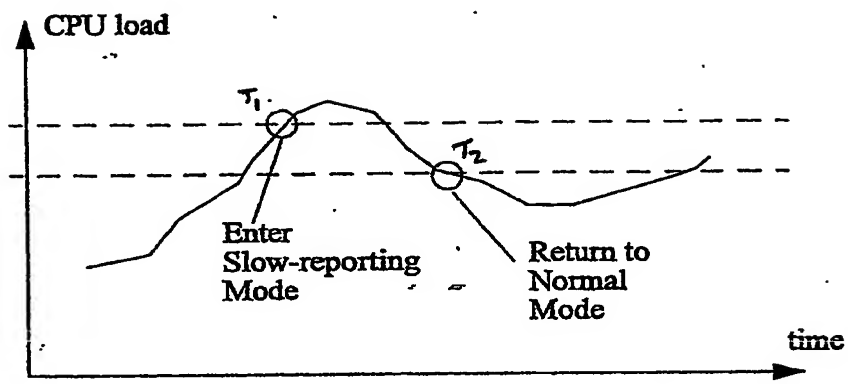
CPU load
T_1
T_2
Enter
Slow-reporting
Mode
Return to
Normal
Mode
time

FIG. 4

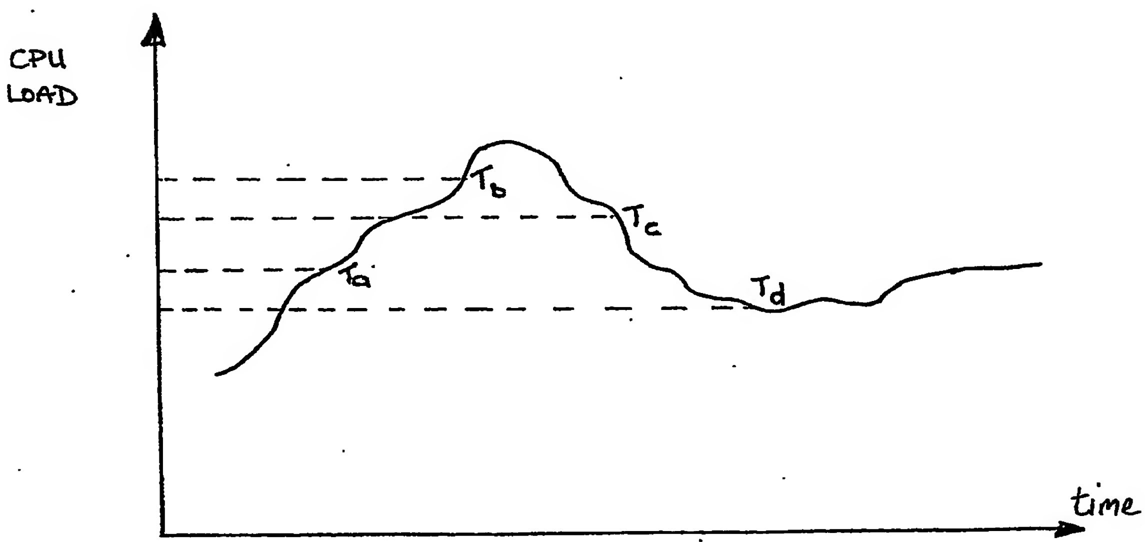
CPU
LOAD
T_b
T_c
T_a
T_d
time

FIG. 5

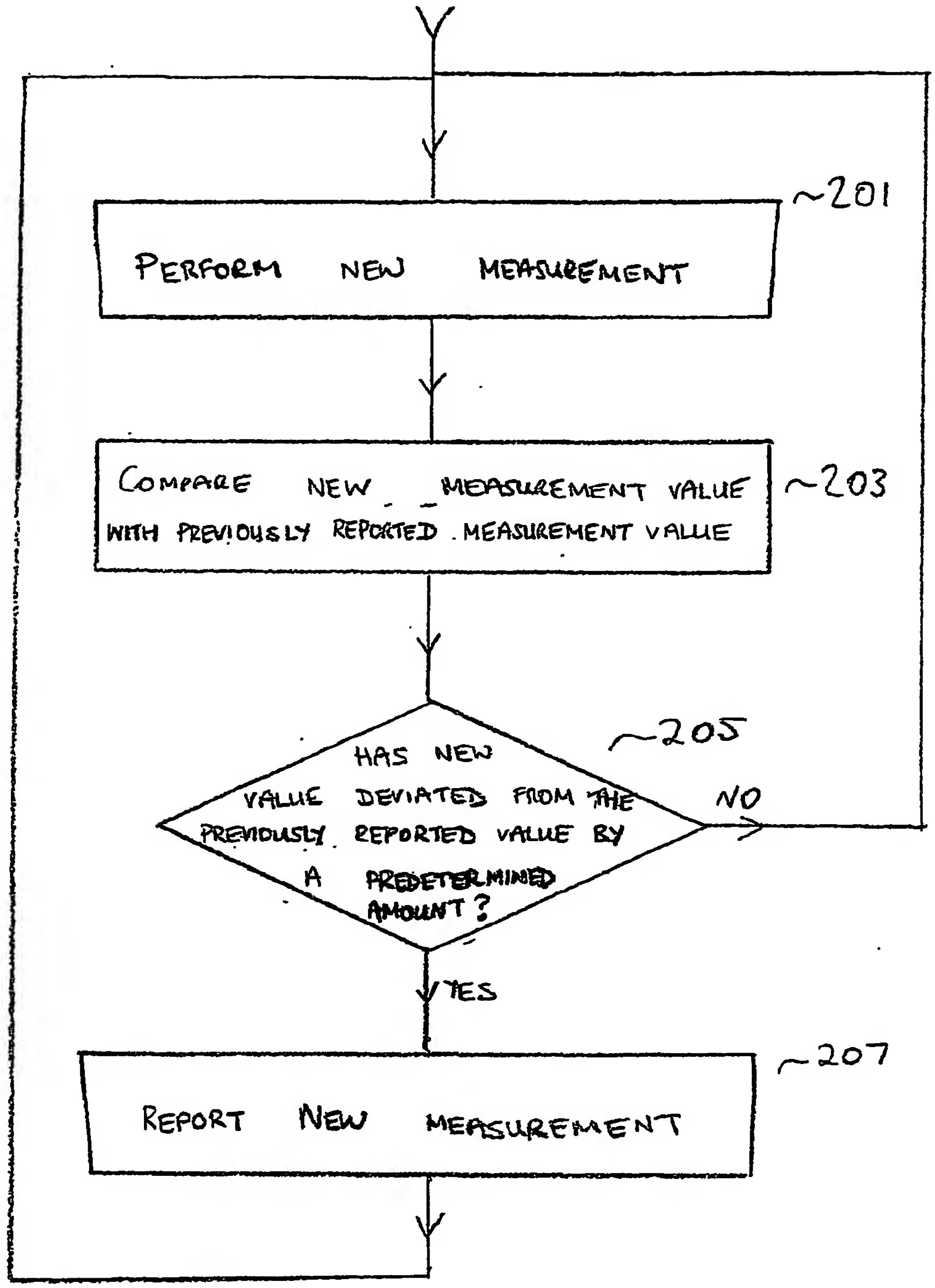
PERFORM NEW MEASUREMENT
201
COMPARE NEW MEASUREMENT VALUE WITH PREVIOUSLY REPORTED MEASUREMENT VALUE
203
HAS NEW VALUE DEVIATED FROM THE PREVIOUSLY REPORTED VALUE BY A PREDETERMINED AMOUNT?
205
NO
YES
REPORT NEW MEASUREMENT
207

FIG 6